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Bikinis Instigate Generalized Impatience in Intertemporal Choice

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Neuroscientific studies demonstrate that erotic stimuli activate the reward circuitry processing monetary and drug rewards. Theoretically, a general reward system may give rise to non-specific effects: Exposure to 'hot stimuli' from one domain may thus affect decisions in a different domain. We show that exposure to sexy cues leads to more impatience in intertemporal choice between monetary rewards. Highlighting the role of a general reward circuitry, we demonstrate that individuals with a sensitive reward system are more susceptible to the effect of sex cues, that the effect generalizes to non-monetary rewards, and that satiation attenuates the effect.

INTRODUCTION

Advertisers search for a way to break through the clutter by using sexually oriented appeals in marketing campaigns. Previous research on the use of sexual imagery in advertising has focused on, among other things, consumer's brand recall and recognition, appeal evaluation, attention, purchase intentions, and product perception. The present study differs from earlier work by showing that the consequences of using sexual imagery extend further than the evaluation of the product or brand itself. In line with previous research demonstrating that exposure to sexual cues influences economic decision making (e.g. Van den Bergh and Dewitte 2006; Wilson and Daly 2004), we will argue that exposure to sexual cues may affect decisions such as whether to purchase a less expensive item that can be enjoyed now or to save for a more expensive one.

Choice is relatively easy when choice alternatives differ on a single dimension: Individuals generally prefer a larger over a smaller reward, and also, a sooner over a later reward. Problems arise when choice options differ on more than one dimension. The choice between a smaller reward available sooner and a larger reward available later is less obvious, because it involves trading off costs and benefits occurring at different times (Frederick, Loewenstein, and O'Donoghue 2002; Green and Myerson 2004; Soman et al. 2005). Delaying a reward reduces the value of that reward and this delay discounting process may be influenced by visceral factors (Loewenstein 1996). An increase in desire, by physical or temporal proximity to rewards, may instigate impatience (Hoch and Loewenstein 1991; Baumeister 2002) and steeper delay discounting of rewards. Recent neuroscientific research suggests that factors producing limbic activation, such as the sight, smell, or touch of a desired object, may be associated with impulsive behavior (McClure et al. 2004). Evidence that speaks to this comes from, among others, studies

employing the delay-of-gratification paradigm (Metcalfe and Mischel 1999). In a typical experiment, a child is offered a less preferred reward and is confronted with the dilemma to wait 15 min and receive a more preferred reward or forego the more preferred reward and immediately receive just the less preferred reward. When the rewards are out of sight, 75% of the children wait 15 minutes to obtain the more preferred reward. However, when the rewards are exposed, the mean delay time drops from more than 11 minutes to about 1 minute. None of the children is capable of resisting temptation or delaying gratification when the rewards are within reach (Mischel and Ebbesen 1970). The exposed rewards (i.e., 'hot stimuli', Metcalfe and Mischel 1999) increase desire and engender impatience (Hoch and Loewenstein 1991; Baumeister 2002), possibly through activation of the limbic system (McClure et al. 2004). The bulk of prior research has demonstrated specific motivational effects of desire (e.g., an increase in desire for food, by exposure to food rewards, leads to impatience for food rewards). On the contrary, we hypothesize that an increase in appetitive motivation may instigate *generalized* impatience in intertemporal choice, through a common reward processing circuitry. We propose that exposure to 'hot stimuli' (Metcalfe and Mischel 1999) leads to a *non-specific* time perspective collapse towards the present. Based on recent neurological findings, suggesting that rewards are processed similarly in the brain, we propose that exposure to 'hot stimuli' may instigate *general* impatience in intertemporal choice. We will argue that a greater appetite causes a greater urgency to consume *anything rewarding*.

CONCEPTUAL FRAMEWORK

Visceral factors may drive impatient and impulsive behaviors (Loewenstein 1996): Hungry people order more food than they can eat (the 'eyes bigger than your stomach' effect),

buy more food than originally intended (Gilbert, Gill, and Wilson 2002; Nisbett and Kanouse 1969), have a stronger preference for candy over fruit (Read and van Leeuwen 1998) and demonstrate less self-control (defined by a greater preference for smaller, less delayed access to apple juice, Kirk and Logue 1997). Other visceral factors such as drug craving cause equivalent short-sighted decisions: Heroin addicts have a heightened preference for smaller, sooner available amounts of heroin over larger, delayed amounts when they are opioid-deprived but not when they are opioid-satiated (Giordano et al. 2002). Likewise, nicotine deprivation causes smokers to become more impatient, defined by an increased preference for immediately available cigarettes (Field et al. 2006; Mitchell 2004). Like other visceral factors, sexual desire may lead to impulse control difficulties. After exposure to photographs high in sex-appeal (Blanton and Gerrard 1997) or during masturbation (Ariely and Loewenstein 2006) men lower their risk estimates for sexually transmitted diseases. In general, visceral factors, such as hunger, drug craving, sexual desire, etc. bring about myopic, impulsive, or impatient decisions.

Previous studies on the impact of visceral factors assume that temporal myopia is good-specific. The implicit assumption that a hungry person would only make short-sighted tradeoffs between immediate and delayed food (and not between immediate and delayed money) is pervasive (Kirk and Logue 1997; Read and van Leeuwen 1998). Loewenstein (1996) explicitly stated that the present orientation applies only to goods that are associated with the visceral factor. Nonetheless, many rewards are processed similarly in the brain (Montague, King-Casas, and Cohen 2006). Neural evidence suggests that the same dopaminergic reward circuitry of the brain is activated for a wide variety of different reinforcers (Camerer, Loewenstein, and Prelec 2005). That is, a similar set of brain reward regions responds in common to very distinct categories of reward – for example, beautiful female faces and erotic stimuli activate the classical reward circuitry that had already been associated with drug and monetary rewards in prior

research (Aharon et al. 2001, Stark et al. 2005). Theoretically, a general neurological system processing rewards may give rise to non-specific effects (Wadhwa, Shiv, and Nowlis 2006). Visceral factors may thus give rise to generalized temporal myopia. A change in the general time preference may impact all intertemporal choices, including those that are unrelated to the factor that caused the change in one's general time preference. Time preference changes may thus be observed in seemingly unrelated domains. Several empirical studies provide support for such an account. Heroin addicts do not only prefer smaller immediate amounts of heroin over larger delayed amounts of heroin when they are opioid deprived, but also prefer smaller sooner available monetary rewards over larger delayed monetary rewards in a drug craving state (Giordano et al. 2002). Likewise, smokers do not only display more pronounced delay discounting of cigarettes after nicotine deprivation, but also of monetary rewards (Field et al. 2006). Most relevant to the current research is the finding that delay discounting of monetary rewards increases in men who viewed attractive women, relative to men who viewed unattractive women (Wilson and Daly 2004). In a similar vein, we propose that activation of the general reward circuitry, by exposure to 'hot stimuli' (i.e., sex cues), leads to general, non-specific effects in reward processing. We hypothesize that exposure to sex cues causes a non-specific time perspective collapse towards the present. More specifically, we predict that sexual cues will increase the preference for a smaller and immediate monetary reward over a larger but delayed monetary reward.

H1: Exposure to sex cues will lead to steeper delay discounting of monetary rewards.

Impulsivity is characterized by generalized reward sensitivity (Ramanathan and Menon 2006). According to Gray's Reinforcement Sensitivity Theory, the Behavioral Approach System

(BAS) is the conceptual substrate for sensitivity to rewards (Gray 1987, 1990) and this system responds with appetitive motivation when such cues are encountered. The purpose of the BAS is to initiate approach behavior that brings the organism closer to reinforcers. Sensitivity to rewarding stimuli can vary substantially from one individual to the next (Carver and White 1994; Torrubia et al. 2001). Individuals with a highly sensitive BAS exhibit a greater tendency to respond to rewards with an increased motivation to engage in reward-seeking behaviors and a greater tendency to act on the hedonic impact of reinforcers. Since erotic stimuli activate the human reward circuitry (Stark et al. 2005), and because sensitivity to rewarding stimuli can vary from one individual to the next (Carver and White 1994; Torrubia et al. 2001), we hypothesize that the extent to which one is sensitive to rewards moderates the effects of sexual cues on delay discounting of monetary rewards. Only when the reward system is sensitive enough to be activated by sex cues, general temporal myopia should be observed. We hypothesize that men with a highly reactive or sensitive behavioral approach system should be affected to a greater extent by sexual cues.

H2: Exposure to sex cues will lead to steeper delay discounting of monetary rewards among high sensitive BAS men than among low sensitive BAS men.

The response to rewards is dependent on the deficit state of an organism. If you don't have money, you may need a smaller sum right now. If you have money, you can afford to wait for a larger sum. Wealthy individuals may display more patience when choosing between a smaller immediate monetary reward and a larger more delayed reward than poor individuals. We propose that satiation impedes a non-specific time perspective collapse towards the present. Indeed, satiation leads to an enhanced capacity of delaying gratification, that is, more patience

(Dholakia, Gopinath, and Bagozzi 2006; Giordano et al. 2002; Kirk and Logue 1997). For example, after ad lib smoking, smokers choose significantly more often a larger, delayed reward over a smaller, more immediate reward than after nicotine abstinence (Field et al. 2006). Also, priming studies indicate that goals dissipate in strength once they are satisfied: Construct accessibility from motivational sources persists as long as the motivation is active, but accessibility is inhibited upon goal fulfillment (Förster, Liberman and Higgins 2005). Hence, satiating the induced motivational state should dampen the appetitive response after exposure to 'hot stimuli' (Wadhwa et al. 2006). Furthermore, satiation in any domain could attenuate the effect of sex cues on impatience. Indeed, Briers et al. (2006) demonstrated that monetary deprivation (satiation) leads to more (less) food intake. Following the logic of the general reward system, it should come as no surprise that monetary satisfaction is capable of satisfying desires evoked by food. Deprivation in one domain can thus affect appetitive responses in a different domain (Briers et al. 2006). Highlighting the role of a general reward mechanism, we propose that satiation in the monetary domain could attenuate the effect of sex cues on intertemporal choice between non-monetary rewards. Because low sensitive BAS individuals are unaffected by sex cue exposure (i.e., hypothesis 2), the effect of satiation should be restricted to high sensitive BAS individuals.

H3: Compared to low sensitive BAS men, deprived high sensitive BAS men will discount *any* reward more steeply than satiated high sensitive BAS men after sex cue exposure.

In the following, we will discuss four experimental studies, to test these hypotheses. In the first two experiments (study 1a and 1b) we will focus on the main effect of sexual cues on

monetary delay discounting (hypothesis 1). In study 2 and 3 we devote our attention to the moderating effects of BAS-sensitivity (hypothesis 2 and hypothesis 3) and satiation/deprivation (hypothesis 3) on delay discounting of rewards across domains.

PREFACE

In all experiments we used a screening procedure to probe attention and motivation. Participants had to answer questions to exclude random response behavior. In study 1a and 1b participants had to answer 4 trivial multiple choice questions about the rules of an unrelated game; and in study 2 and 3 they were instructed not to respond to a scale but to click a blue dot next to the question (Oppenheimer, Meyvis, and Davidenko, 2007). Data from participants not answering these questions correctly [study 1a: n = 2 (i.e., 7%); study 1b: n = 10 (i.e., 13%); study 2: n = 4 (i.e., 3%); study 3: n = 7 (i.e., 5%)] were discarded, because their responses on focal variables can not be trusted.

STUDY 1a

In the first study, our aim is to demonstrate that exposure to sexual cues leads to monetary craving. Delaying a reward reduces the value of that reward (Frederick et al. 2002; Green and Myerson 2004) and we hypothesize that proximity to 'hot stimuli' leads to an even steeper reduction of subjective value of monetary rewards throughout the time (hypothesis 1).

Participants

Participants were 42 heterosexual male students and their ages ranged from 18 to 28 years (M = 22; SD = 1.98). Three students participated in order to receive partial course credit and 39 students participated in return for a participation fee.

Method

Participants were seated in partially enclosed cubicles, which prevented them from having contact with each other. In the picture rating task, 15 advertisements were displayed in a random order on a computer screen. Participants rated the attractiveness of the advertisements. Two sets of 15 pictures constituted the stimulus materials. In the "landscape condition", 15 pictures of landscapes (beaches, fields, mountain ranges, riversides, etc…) were displayed and in the "sexy women condition", 15 pictures of non-nude female models were shown to the participants. The models assumed different poses and wore diverse outfits, but all were dressed in a sexually appealing manner (e.g., swimsuit or lingerie). The pictures of the landscapes and sexy women would supposedly be used for a marketing campaign. Participants were instructed to rate the attractiveness of the ads on a seven-point scale ranging from -3 (not attractive at all) to +3 (very attractive).

Subsequently, participants engaged in a delay discounting task. Participants specified the amount of money they would require in one week and the amount they would require in one month to make them indifferent to receiving €15 now (Thaler 1981). This procedure allows us to specify a discounting function for each participant. Following Myerson, Green, and Warusawitharana (2001), we consider the area under the empirical discounting function as a measure of delay discounting. The area under the curve can vary between 0.0 (steepest possible discounting) and 1.0 (no discounting) (see Myerson et al. 2001 for details regarding the

calculation of the area under the curve). The area measure provides a single and easy statistic that can be used to compare groups and does not depend on any theoretical assumptions regarding the form of the discounting function (Myerson et al. 2003). We employed a hypothetical delay discounting task. Although the use of real rewards is desirable for obvious reasons, there is, as of yet, no clear evidence that hypothetical rewards are discounted differently from real rewards (Johnson and Bickel 2002; Lagorio and Madden 2005; Madden et al. 2003, 2004).

If exposure to sexual cues leads to changes in affect, this may influence impulsivity. For instance, one's mood could influence impulse buying (Rook and Gardner 1993): People who feel happy may be inclined to reward themselves generously and to feel as if they have more freedom to act. On the other hand, when people are upset, they indulge in immediate impulses to make themselves feel better (Tice, Bratslavsky, and Baumeister 2001). Also, emotions of happiness and sadness may influence the likelihood of self-gifts and explain immediate gratification (Mick and Faure 1998). To test whether self-reported mood states were not different across conditions, participants' mood was assessed on a five-point scale ranging from 1 (not at all) to 5 (extremely) by means of the Positive Affect Negative Affect Schedule (PANAS; Watson, Clark, and Tellegen 1988). In addition, we assessed arousal and mood valence by the Self-Assessment Manikin (SAM, Morris 1995), a pictorial scale with 5 graphic figures. Participants were instructed to indicate which of the 5 SAM figures corresponds to their current emotional state on a visual analogue scale (100 points). For the arousal dimension, the SAM figures range from a wide-eyed, excited figure, to a relaxed, sluggish, or sleepy figure. For the mood valence dimension, SAM ranges from a smiling, happy figure, to a frowning, unhappy figure. Positive affect, negative affect, mood valence and arousal were assessed after the discounting measure to demonstrate that the effect might occur when mood/arousal are not salient. In studies 2 and 3, mood/arousal was assessed prior to the discounting measure.

Results

Two outliers were removed. An observation is declared an outlier if it lies outside of the interval [Q1-1.5×IQR; Q3+1.5×IQR], where IQR=Q3-Q1 is called the Interquartile Range (Tukey 1977). We will use this definition across the four experimental studies. An analysis of variance revealed a significant effect of the content of the advertisements, $F(1, 38) = 8.54$, $p < .01$, on delay discounting of money. After exposure to pictures of sexy women, men discounted money more steeply, which was reflected by a smaller area under the empirical discounting function in the sexy women condition ($M = .82$, SD = .11) than in the landscape condition ($M = .90$, SD = .06), see figure 1.

Insert figure 1 about here

The effect of sexual cues on delay discounting is not likely to be driven by mood differences: Levels of positive and negative affect (PANAS; Watson, Clark, and Tellegen 1988) did not differ between conditions and neither did mood valence and arousal (SAM; Morris 1995). Adjusting for positive and negative affect, mood valence and arousal as covariates did not change the pattern of results reported above, suggesting that mood did not mediate the effect of sexual cues on delay discounting.

Also, the effect of sexual cues on delay discounting cannot be explained by the attractiveness of the pictures. Pictures were rated equally attractive in both conditions (landscape: $M = 1.35$; SD = .76; sexy women: $M = 0.99$; SD = .96; $F(1, 38) = 1.71$, NS). Adjusting for the

attractiveness of the pictures as covariates did not change the pattern of results, suggesting that attractiveness did not mediate the effect of sexual cues on delay discounting.

Discussion

After exposure to sexual cues, men have a heightened preference for immediately available rewards over larger and delayed monetary rewards. Although this is consistent with our contention that sexual cues instigate monetary craving, the mere presence of other persons is likely to influence impulse buying (Luo 2005). It is possible that the mere suggestion of the presence of an individual (in the sexy women condition) versus the absence (in the landscape condition) is causing impatience.

STUDY 1b

In study 1b our goal is twofold: First, we aim to corroborate the result of study 1a that exposure to sexual cues increases impatience in the monetary domain (hypothesis 1). Second, we attempt to rule out the possibility that the induced impatience is driven merely by the presence of an individual by using person-free sexual cues. Also, this rules out an explanation in terms of the attractiveness of female models (Wilson and Daly 2004).

Participants

Participants were 67 heterosexual male students and their ages ranged from 17 to 34 years (M = 21; SD = 2.62). Seventeen students participated in order to receive partial course credit and 50 students participated in return for a participation fee.

Method

The same laboratory setting from the previous study was used. Supposedly to explore the underlying causes of the popularity of several clothing items, participants were asked to rate a piece of clothing on several dimensions. In the "T-shirt condition", a T-shirt was evaluated on several aspects (such as quality, color,...) and in the "bra condition", a bra was rated on the same dimensions. Eight different T-shirts and eight different bras were randomly allocated to the participants and they could evaluate one clothing item by touching, feeling, visually inspecting etc.

Subsequently, participants engaged in a delay discounting task. Participants specified the amount of money they would require in one week and the amount they would require in one month to make them indifferent to receiving €15 now. We consider the area under the empirical discounting function as a measure of delay discounting (Myerson et al. 2001).

After the delay discounting task, participants' mood was assessed by means of the Positive Affect Negative Affect Schedule (PANAS; Watson et al. 1988), and arousal and mood valence by the Self-Assessment Manikin (SAM, Morris 1995), to test whether self-reported mood states were not different across conditions.

Results

One outlier was removed. An analysis of variance revealed a significant effect of the clothing, $F(1, 64) = 8.61$, $p < .005$, on delay discounting of monetary rewards. After exposure to lingerie, men discounted money more steeply, which was reflected by a smaller area under the empirical discounting function in the bra condition ($M = .80$, SD = .13) than in the T-shirt condition ($M = .88$, SD = .08), see figure 2.

Insert figure 2 about here

The effect of sexual cues on delay discounting is not likely to be driven by mood differences. Levels of positive and negative affect (PANAS; Watson, Clark, and Tellegen 1988) did not differ between conditions and neither did mood valence and arousal (SAM; Morris 1995). Adjusting for positive and negative affect, mood valence and arousal as covariates did not change the pattern of results reported above, suggesting that mood did not mediate the effect of sexual cues on delay discounting.

Discussion

Male participants require more money in the future to make them indifferent to receiving €15 now after exposure to a bra than after exposure to a T-shirt. That is, sexual cues lead to steeper discounting of money. This finding is consistent with study 1a and suggests that sexual cues lead to a non-specific collapse of time perspective toward the present, supporting the role of a general reward system. Unlike earlier research, steeper discounting of monetary rewards after exposure to sexual cues cannot be due to the attractiveness of female models (Wilson and Daly 2004) and is not driven merely by the presence of an individual (Luo 2005). In study 2 and 3 we

explore the underlying mechanism giving rise to this effect. More specifically, we will focus on the moderating effects of BAS-sensitivity and satiation/deprivation.

STUDY 2

Our goal in the second study is twofold. First, our aim is to demonstrate that men with a highly sensitive reward system are more likely to be influenced by sexual cues (hypothesis 2). Our second objective is ruling out an explanation in terms of distraction or cognitive capacity.

The Behavioral Approach System (BAS) is sensitive to reward stimuli and responds with appetitive motivation when rewards are encountered. Since erotic stimuli activate the human reward circuitry (Stark et al. 2005), and because sensitivity to rewarding stimuli can vary from one individual to the next (Carver and White 1994; Torrubia et al. 2001), we conjecture that the extent to which one is sensitive to rewards moderates the effects of sexual cues on delay discounting of monetary rewards. Only when the reward system is sensitive enough to be activated by sex cue exposure, a time preference shift should be observed. More specifically, we hypothesize that men with a highly sensitive behavioral approach system (as assessed with the 'Sensitivity to Punishment / Sensitivity to Reward' Questionnaire, SPSRQ; Torrubia et al. 2001) discount monetary rewards more steeply after sex cue exposure than men who are insensitive to rewards.

To the extent that sexual cues distract or cognitively load participants, the reported effects in our earlier studies could be due to lower working memory capacity (Shiv and Fedorikhin 1999). Indeed, Hinson, Jameson, and Whitney (2003) found that a secondary task (a digit memory task) increased the preference for immediate rewards in a delay discounting task. It is well known that cognitive load decreases performance on a variety of cognitive tasks (e.g.,

Baddeley 1996; Baddeley, Chincotta, and Adlam, 2001; Toms, Morris, and Ward, 1993). If sexual cues increase working memory load, performance on cognitive tasks should decrease. The Remote Associates Test (RAT; Mednick 1962) is a cognitive test measuring creativity, whereby creativity is narrowly defined as the ability to make rapid appropriate associations between various concepts. A RAT question consists of providing people three words (e.g., "dress, dial, flower") and giving them a limited amount of time (15 seconds in the current study) to come up with the one correct word linked to all three of the original words ("sun"). If sex cues would impair working memory capacity, a decrease in performance should be observed in the sex cue condition. In contrast, we hypothesize that an amelioration of RAT performance will be observed after exposure to a sex cue (see Griskevicius, Cialdini, and Kenrick, 2006). Because activation of the reward circuitry increases creativity (Eisenberger, Armeli, and Pretz 1998), our theory explicitly predicts that RAT performance should vary in an analogous way as delay discounting. That is, the increase in RAT performance after sex cue exposure should be more pronounced among men who possess a sensitive reward system.

Participants

Participants were 120 heterosexual male students and their ages ranged from 18 to 39 years (M = 21; SD = 2.31). All students participated in return for a participation fee.

Method

The same laboratory setting from the previous studies was used. All participants first viewed a 1 min. advertising commercial. In the "control condition", the commercial video

featured hundreds of men sprinting through a scenery and in the “sex cue condition”, the commercial video contained hundreds of young women, dressed in bikinis, running across hills, fields, and beaches. Participants were instructed to watch the commercial carefully since they would be asked questions about it at a later point in time.

To test whether self-reported mood states were not different depending on condition, participants’ mood was assessed immediately after exposure to the commercial by means of the Positive Affect Negative Affect Schedule (PANAS; Watson et al. 1988), mood valence, and arousal on a visual analogue scale by the Self-Assessment Manikin (Morris 1995).

Subsequently, participants engaged in a delay discounting task. Participants specified the amount of money they would require in one week and the amount they would require in one month to make them indifferent to receiving €15 now. As in study 1a and 1b, we consider the area under the empirical discounting function as a measure of delay discounting (Myerson et al. 2001).

To rule out a distraction explanation, the RAT was administered. Participants had to solve 5 RAT questions and had 15 s to answer each question. The correct responses to the RAT questions were summed and subjected to statistical analyses.

Afterwards, respondents answered the Sensitivity to Punishment Sensitivity to Reward Questionnaire (SPSRQ) (Torrubia et al. 2001), a scale specially developed to assess Gray's behavioral approach and inhibition constructs, which consists of 48 yes/no items such as “Do you often do things to be praised?” (SR) and “Are you often afraid of new or unexpected situations?” (SP). The 24 Sensitivity to Reward (SR) items were averaged to obtain an SR score (Cronbach’s alpha = .71). Including the Sensitivity to Punishment scale in statistical analyses didn’t produce any significant effects and is ignored in the remainder.

Results

For the analysis on the delay discounting task, 4 outliers were removed. A general linear model (GLM) analysis was used for the analysis. The GLM combines features of ANOVA and regression based models and can therefore handle any combination of continuous and discrete variables. In the analysis, Commercial (sexy/control) was entered as a discrete between subjects factor, whereas Sensitivity to Reward (SR) was entered as a continuous between subjects factor. This GLM revealed a significant effect of the content of the commercial on delay discounting of money, $F(1, 112) = 5.14$, $p < .05$. After exposure to a sexy commercial, men discounted money more steeply, which was reflected by a smaller area under the empirical discounting function in the sexy cue condition ($M = .84$, SD = .12) than in the control condition ($M = .85$, SD = .11). Furthermore, the analysis yielded a significant main effect of SR scores, $F(1, 112) = 11.43$, $p < .005$, demonstrating that men with a more sensitive reward system discounted money more steeply than men with a less sensitive appetitive system ($r = -.29$, $p < .005$, $n = 116$). These two main effects were qualified by a significant interaction between the content of the commercial and SR scores ($F(1, 112) = 6.40$, $p < .05$). That is, the correlation between SR scores and discounting was not significant in the control condition ($r = -.08$, $p = .54$, $n = 58$) but there was a significant negative correlation between SR scores and discounting in the sex cue condition ($r = -.48$, $p < .0001$, $n = 58$), indicating that greater sensitivity for reward is associated with a smaller area under the empirical delay discounting function of money, but only when men have been previously exposed to a sexy commercial. To visualize these data, the distribution of the SR scores was dichotomized on the basis of a median split to define a high and low sensitive to reward group, ($Mdn = 14$; $M_{high} = 16.89$, $M_{low} = 10.67$). Planned contrasts revealed that the high sensitive to reward group discounts rewards more steeply, $t(112) = 1.96$, $p = .05$, after exposure

to a sexy commercial (M = .77, SD = 0.13) than after exposure to a control commercial (M = .83, SD = .12), see figure 3. Within the low sensitive to reward group however, exposure to sex cues did not lead to steeper discounting of rewards, $t(112) = 0.70$, NS. That is, after sex cue exposure, men with a sensitive reward system discount rewards more steeply, $t(112) = 4.31$, $p < .0001$, than men who are insensitive to rewards (M = 0.88, SD = .07), see figure 3.

Insert figure 3 about here

A GLM analysis revealed a marginally significant effect of the content of the commercial on RAT performance, $F(1, 116) = 3.16$, $p = .078$. After exposure to a sexy commercial, men were more likely (M = 2.05, SD = 1.34) to come up with the one correct word (e.g., "sun") linked to all three of the original words (e.g., "dress, dial, flower") than in the control condition (M = 1.92, SD = 1.36). The analysis yielded no significant main effect of SR scores, $F(1, 116) = 1.29$, $p = .26$, but a significant interaction between condition and SR scores was obtained, $F(1, 116) = 4.05$, $p < .05$. That is, the correlation between SR scores and RAT performance was not significant in the control condition (r = -.08, p = .53, n = 60) but there was a significant positive correlation between SR scores and RAT performance in the sex cue condition (r = .28, $p < .05$, n = 60), indicating that greater sensitivity for reward is associated with better performance on a cognitive task, but only after exposure to a sexy commercial. Planned contrasts revealed that the high sensitive to reward group (M = 2.5, SD = 1.37) is more likely to come up with one correct word linked to all three of the original words after a sexy commercial, $t(116) = 2.17$, $p < .05$, than the low sensitive to reward group (M = 1.75, SD = 1.22). After the control commercial however, no differences in RAT performance between the high sensitive to reward group (M = 1.88, SD =

1.18) and the low sensitive to reward group (M = 1.97, SD = 1.51) was obtained, $t(116) = 0.25$, NS, see figure 4.

Insert figure 4 about here

The effect of sexual cues on delay discounting or creativity is not likely to be driven by mood differences. Levels of negative affect, mood valence, and arousal did not differ significantly between conditions. Levels of positive affect (control: M = 3.35, SD = .61; sex cue: M = 3.14, SD = .64; $F(1, 118) = 3.37$, p=.069) showed a trend towards significant differences between conditions, but adjusting for positive and negative affect, mood valence, and arousal as covariates did not change the pattern of results reported above, suggesting that mood does not mediate the effect of sexual cues on delay discounting or creativity.

Discussion

In this second study we demonstrated that the extent to which one is sensitive to rewards moderates the effects of sexual cues on delay discounting: Men with a highly sensitive BAS discount monetary rewards more steeply after sex cue exposure than men who are insensitive to rewards. Hence, activating the reward system by exposure to sexual cues leads to a greater valuation of immediately available monetary resources. Additionally, this experiment rules out an explanation in terms of distraction or working memory load (Hinson et al. 2003; Shiv and Fedorikhin 1999). Consistent with Griskevicius et al. (2006) and Eisenberger et al. (1998), reward sensitive men perform better on a cognitive creativity task after watching a sexy commercial.

STUDY 3

In study 3 our goal is threefold. First, we aim to replicate the result of study 2 by demonstrating that the effect of sexual cues on delay discounting is moderated by BAS sensitivity (hypothesis 2) (Carver and White 1994; Torrubia et al. 2001). Second, we want to provide further support for the role of a general reward mechanism in delay discounting of rewards, by demonstrating that the effect of sexual cues is not restricted to the monetary domain, but generalizes to different types of reward, such as candy and soft drinks (hypothesis 3). Additionally, this would rule out an explanation in terms of mate attraction: Roney (2003) demonstrated that exposure to potential mates primes a psychological orientation in men that accords elevated importance to current material wealth. If we could demonstrate effects among rewards unrelated to material wealth, an explanation in terms of mate attraction would be convincingly ruled out. Third, we propose that satiety leads to an enhanced capacity to delay gratification (Dholakia et al. 2006; Field et al. 2006; Giordano et al. 2002; Kirk and Logue 1997): Satiating the induced motivational state should attenuate the appetitive response after exposure to 'hot stimuli'. Since deprivation in one domain can affect appetitive responses in a different domain (Briers et al. 2006), we propose that exposure to sexual cues will lead to steeper delay discounting of rewards such as candy and soft drinks, but only when individuals feel monetarily deprived, not when individuals feel monetarily satiated (hypothesis 3). This would provide strong support for our motivational account (i.e., sex cues instigate appetitive motivation) and rule out an explanation in terms of trait priming or behavioral effects of stereotype activation (i.e., sex cues prime the male stereotype and activate the trait of impulsivity, Wheeler and Petty 2001).

Participants

Participants were 129 heterosexual male students and their ages ranged from 17 to 25 years (M = 19; SD = 1.41). All students participated in return for course credit.

Method

The same laboratory setting from the previous studies was used. As in study 1b, participants were asked to rate either a T-shirt (control condition) or a bra (sex cue condition) on several dimensions. Eight different T-shirts and eight different bras were randomly allocated to the participants and they could evaluate one clothing item by touching, feeling, visually inspecting etc.

Afterwards, participants were asked to indicate the combined amount of money in their checking and savings accounts. The response scale constituted the independent variable (Nelson and Morrison 2005). Half of the participants were given an nine-point scale divided in €50 increments, from 1 (€0–€50) to 9 (over €400), whereas the other half were given a similar nine-point scale divided in much larger increments, from 1 (€0–€500) to 9 (over €400,000). When participants respond toward the top or bottom of a scale, they tend to make corresponding inferences about their personal circumstances (Schwarz 1999). People responding to the €400,000 scale feel monetarily deprived, whereas people responding to the €400 scale feel monetarily satiated (Nelson and Morrison 2005).

To test whether self-reported mood states were not different depending on condition, participants' mood was assessed immediately after the manipulations by means of one item ("How do you feel at this moment?", on a nine-point scale anchored on "very bad" (1) and "very

good" (9)) and arousal and mood valence on a visual analogue scale by the Self-Assessment Manikin (Morris 1995).

Subsequently, participants engaged in a delay discounting task. Participants had to specify how many [euros / cans of soda pops / candy bars] they would require in 1 [week / month] to make them indifferent to receiving 15 [euros / cans of soda pops / candy bars] now (Estle et al. 2007). As in the previous studies, we consider the area under the empirical discounting function of each reward as a measure of delay discounting (Myerson et al. 2001).

Next, BAS-sensitivity was assessed: Because of time constraints we preferred the shorter BIS/BAS scales (20 items, Carver and White 1994) over the longer SPSRQ scale (48 items, Torrubia et al. 2001). The BIS/BAS scales yields scores on three BAS subscales (reward responsiveness, fun-seeking, and drive) and one BIS subscale. For the purposes of this study only the Reward Responsiveness subscale is utilized, because this scale focuses on the responses to the occurrence of reward (Carver and White 1994) and is most relevant for the effect of sexual cues on activation of the general reward system. Including the BIS scale or the other BAS subscales (i.e., fun-seeking, drive) in further statistical analyses didn't produce any significant effects and is ignored in the remainder. Participants responded to nine-point scale items anchored on "strongly disagree" (1) and "strongly agree" (9) on statements such as "When I'm doing well at something, I love to keep at it". The responses to the BAS Reward Responsiveness subscale were averaged to form a composite reward sensitivity score (alpha = .71).

Results

Nine outliers were removed. For each reward (money, soda, candy), the area under the discounting curve was standardized and these three standardized measures were subjected to a

repeated measurement GLM analysis with Motivation (deprivation/satiation), Clothing (bra/T-shirt), Reward Responsiveness (as a continuous factor), and all interactions as independent variables. This analysis revealed no significant within subjects effects, suggesting that all three discounting measures are affected in a similar way by the independent variables and their interactions (all F's < 1.30). The between subject analysis of variance yielded a significant two-way interaction between Motivation and Clothing, $F(1, 112) = 5.57$, $p < .05$, and a significant three-way interaction between Motivation, Clothing, and Reward Responsiveness, $F(1, 112) = 5.81$, $p < .05$. To explore these interaction effects and to provide an explicit comparison with study 2, two separate GLMs were conducted within the deprivation and satiation conditions. Because study 2 can be considered as a non-satiation study, we should replicate the effects of study 2 within the deprivation condition of study 3. Indeed, within the deprivation conditions, a GLM with Reward Responsiveness and Clothing as independent variables yielded a significant main effect of Clothing, $F(1, 58) = 5.48$, $p < .05$, a marginally significant effect of Reward Responsiveness, $F(1, 58) = 3.77$, $p = .06$, and a significant two-way interaction, $F(1, 58) = 6.57$, $p < .05$. Within the satiation conditions however, neither the main effects nor the interaction effect was significant (all F's < 1). The significant three-way interaction between Motivation, Clothing, and Reward Responsiveness, can be explored by investigating the correlation between the delay discounting measures and Reward Responsiveness within each experimental condition (see table 1).

Insert table 1 about here

The correlation between Reward Responsiveness and delay discounting is significant after sex cue exposure, but only if individuals feel monetarily deprived ($r = -.46$, $p < .01$, $n = 32$). That

is, the more sensitive the reward system, the steeper the delay discounting curve after exposure to sex cues. This correlation disappears if individuals feel monetarily satiated after sex cue exposure (r = .10, p = .59, n = 30). In the T-shirt conditions, no association between discounting and Reward Responsiveness is obtained. As suggested by the absence of within subjects effects, this correlation pattern is found for each reward separately. That is, touching a bra leads to steeper delay discounting of money, candy bars, and soda pops, among men with a sensitive reward system than among men with a less sensitive reward system, but not after monetary satiation (see table 1).

To visualize these data, the distribution of the Reward Responsiveness scores was dichotomized on the basis of a median split to define a high and low sensitive to reward group, (Mdn = 7.1; M_{high} = 7.78, M_{low} = 6.41). Also, a general delay discounting of rewards index was constructed by averaging the three standardized area under the curve measures (alpha = 0.70). Planned contrasts revealed that the high sensitive to reward group, when monetarily deprived, discounts rewards more steeply, $t(119) = 3.42$, $p < .001$, after exposure to lingerie (M = -0.47, SD = 1.11) than after exposure to a T-shirt (M = .31, SD = .45), see figure 5. The high sensitive to reward group, when monetarily satiated, however, did not discount rewards more steeply $t(119) = 1.10$, NS, after exposure to lingerie (M = .07, SD = .57) than after exposure to a T-shirt (M = .35, SD = .47). That is, after sex cue exposure, men with a sensitive reward system discount rewards more steeply when they feel deprived, than when they feel satiated $t(119) = 2.26$, $p < .05$. Within the low sensitive to reward group however, none of these contrasts is significant, see figure 5.

Insert figure 5 about here

This pattern is obtained for each reward separately. That is, touching a bra leads to steeper delay discounting of money, soda pops and candy bars, only among men with a sensitive reward system, but not after monetary satiation (see figures 6, 7 and 8).

Insert figures 6, 7 and 8 about here

The effect of sexual cues on delay discounting is not likely to be driven by mood differences: No significant differences in mood, mood valence, and arousal were obtained between conditions and adjusting for these variables as covariates in the reported analyses did not change the pattern of results, suggesting that mood did not mediate the effect of sexual cues on delay discounting.

Discussion

In this third study we provided further support for the role of a general reward mechanism in delay discounting of rewards. We replicated the result of study 2 by demonstrating that the effect of sexual cues on delay discounting is moderated by BAS sensitivity. Furthermore, we demonstrated that the effect of sexual cues is not restricted to the monetary domain, but generalizes to different types of reward, such as candy bars and soda pops. This rules out an explanation in terms of mate attraction because we obtained effects among rewards not directly related to material wealth. Finally, we found that satiating the induced motivational state dampens the appetitive response after exposure to 'hot stimuli'. Not only does this rule out an explanation in terms of behavioral effects of stereotype activation (Wheeler and Petty 2001),

these results are also difficult to reconcile with a mere arousal account: It is unlikely that our satiation/deprivation manipulation would eliminate arousal induced by 'hot stimuli' exposure.

GENERAL DISCUSSION

This research attempted to investigate whether exposure to 'hot stimuli' leads to a general time perspective collapse towards the present. The present studies demonstrate that sexual appetite induces monetary craving. In line with neurological findings suggesting that rewards are processed similarly in the brain, we've provided evidence that a general reward system is giving rise to this effect. Among individuals with an insensitive reward system, sex cue exposure does not give rise to generalized impatience. Only when the reward system is sensitive enough to be activated by sex cue exposure, a time preference shift towards the present was observed. We showed that the effect is not restricted to monetary rewards: Sex cue exposure leads to impatience for candy bars and soda pops as well. These results suggest that an induced sexual appetite instigates a greater urgency to consume *anything* rewarding. Further evidence for the role of the general reward system was provided by demonstrating that monetary satiation could attenuate the effect of sex cues on impatience in *any* domain. After touching a bra, monetary satiation leads to shallower discounting of candy bars, and soda pops than monetary deprivation. Additionally, we have ruled out explanations in terms of mood/arousal (Mick and Faure 1998; Rook and Gardner 1993; Tice et al. 2001), presence of individuals (Luo 2005), attractiveness of female models (Wilson and Daly 2004), cognitive load (Hinson et al. 2003; Shiv and Fedorikhin 1999), mate attraction (Roney 2003), and stereotype activation (Wheeler and Petty 2001).

Our brains include motivational mechanisms designed to ensure that we have sex when the situation is propitious for reproduction, eat when nutritionally deficient, drink when thirsty,

and so forth. Prior research indicated that cues commonly associated with opportunities for having sex, lead to an increase in motivation or desire to have sex. For instance, masturbating men report a greater willingness to take morally dubious measures to procure sex, find a much wider range of activities sexually appealing, and report a greater willingness to engage in risky sexual activities (Ariely and Loewenstein 2006). We demonstrated that this increase in appetitive motivation may emerge in domains that are unrelated to the cues that instigated the increase in appetitive motivation. Our research suggests that prior exposure to sexy stimuli may influence the choice between chocolate cake or fruit for dessert. As such, this series of experiments contributes to a growing body of research showing out-of-domain effects of visceral states (Briers et al. 2006; Field et al. 2006; Giordano et al. 2002; Wilson and Daly 2004) and supports arguments for a common 'neural currency' of reward (Montague and Berns 2002).

This is not to say that intertemporal choice would be regulated by one single valuation mechanism. Brain imaging research suggests that intertemporal choice can be viewed as a splice of two processes -an impulsive, affective, hot process, and a more far-sighted, cognitive, cool process (Camerer et al. 2005; McClure et al. 2004). Different neurological regions are activated by decisions involving rewards available today and decisions involving intertemporal choices irrespective of delay. Parts of the affective system are preferentially activated by immediately available rewards. In contrast, more cognitive regions are engaged by intertemporal choices irrespective of delay (McClure et al. 2004). Thus, delay discounting reflects the operation of more than one single valuation mechanism (Montague et al. 2006). We would like to stress that our conclusions may be restricted to immediate rewards (i.e., short-run impatience is driven by the affective, limbic system, McClure et al. 2004) and may not generalize to choice between two delayed rewards. We think it is plausible that 'hot stimuli' exposure may not lead to generalized impatience if individuals have to match a future reward (e.g., €15 in a year) with an even more

delayed reward. Long-run patience is mediated by neurological activity within the more cognitive structures (McClure et al. 2004), which may be unaffected by 'hot stimuli' exposure. Hence, this research provides evidence that one single mechanism may value all immediate rewards, but we remain ignorant about the specificity of the valuation mechanism for delayed rewards. Our conclusions may thus be restricted to decisions between now and the future.

It is appropriate to acknowledge the limitations of the present study. First, our samples were composed of young male students, which poses problems for generalization across populations. Indeed, prior research with female participants failed to find similar effects (Wilson and Daly 2004). Sex cues may not activate a general reward mechanism in women, but we nonetheless propose that 'hot stimuli' exposure may lead to analogous effects within a female population. Indeed, Briers et al. (2006) found that an increase in desire for food, instigated by the scent of freshly baked brownies, leads to monetary craving among a female population. This brings us to the second limitation of the present research: We only addressed the effect of sexual cues. Nevertheless, we hypothesize that *any* increase in appetitive motivation may lead to generalized temporal myopia. For example, future research may explore the reverse effect of the present experiments: Does monetary deprivation leads to steeper delay discounting of sexual rewards (e.g., specify the number of minutes of sexual activity with your favorite movie star you would require in one week to make you indifferent to receiving 15 minutes of sexual activity right now)? On the one hand, one may observe steeper discounting of sexual rewards after 'hot stimuli' exposure and find similar results as reported above. On the other hand, individuals may derive more pleasure from delaying a sexual reward (e.g., Loewenstein 1987): A longer time delay may enhance the hedonic effect of anticipation of a sexual reward, which may lead to a shallower discounting function after 'hot stimuli' exposure.

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TABLE 1

CORRELATIONS BETWEEN REWARD RESPONSIVENESS AND DELAY DISCOUNTING OF DIFFERENT REWARD ITEMS WITHIN EACH EXPERIMENTAL CONDITION (EXPERIMENT 3)

TABLE 1

CORRELATIONS BETWEEN REWARD RESPONSIVENESS AND DELAY DISCOUNTING OF DIFFERENT REWARD ITEMS WITHIN EACH EXPERIMENTAL CONDITION (EXPERIMENT 3)

	Sex		Control	
	Deprivation (n=32)	Satiation (n=30)	Deprivation (n=30)	Satiation (n=28)
Money	-0,45*	-0,17	0,02	-0,26
Candy	-0,35*	0,21	0,17	-0,03
Soda	-0,38*	0,16	0,05	0,04
Mean reward	*-0,46***	*0,1*	*0,11*	*-0,09*

* p < 0,05; ** p < 0,01

FIGURE 1

DELAY DISCOUNTING OF A MONETARY REWARD (EXPERIMENT 1A)

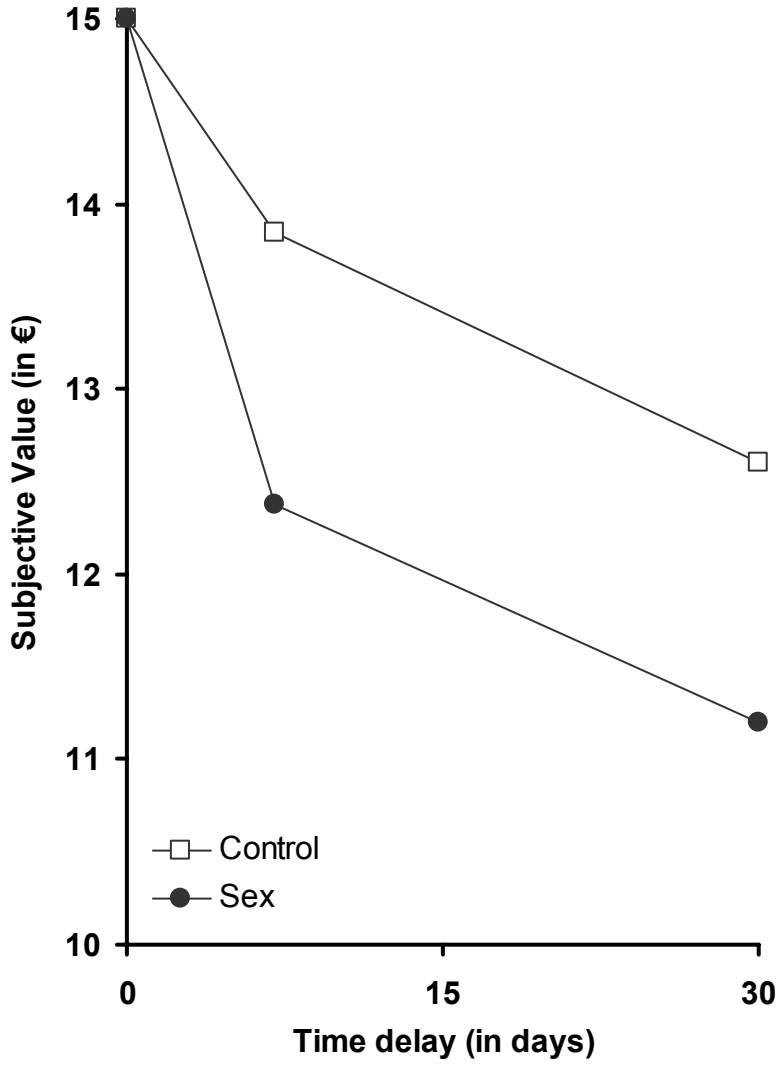

FIGURE 2

DELAY DISCOUNTING OF A MONETARY REWARD (EXPERIMENT 1B)

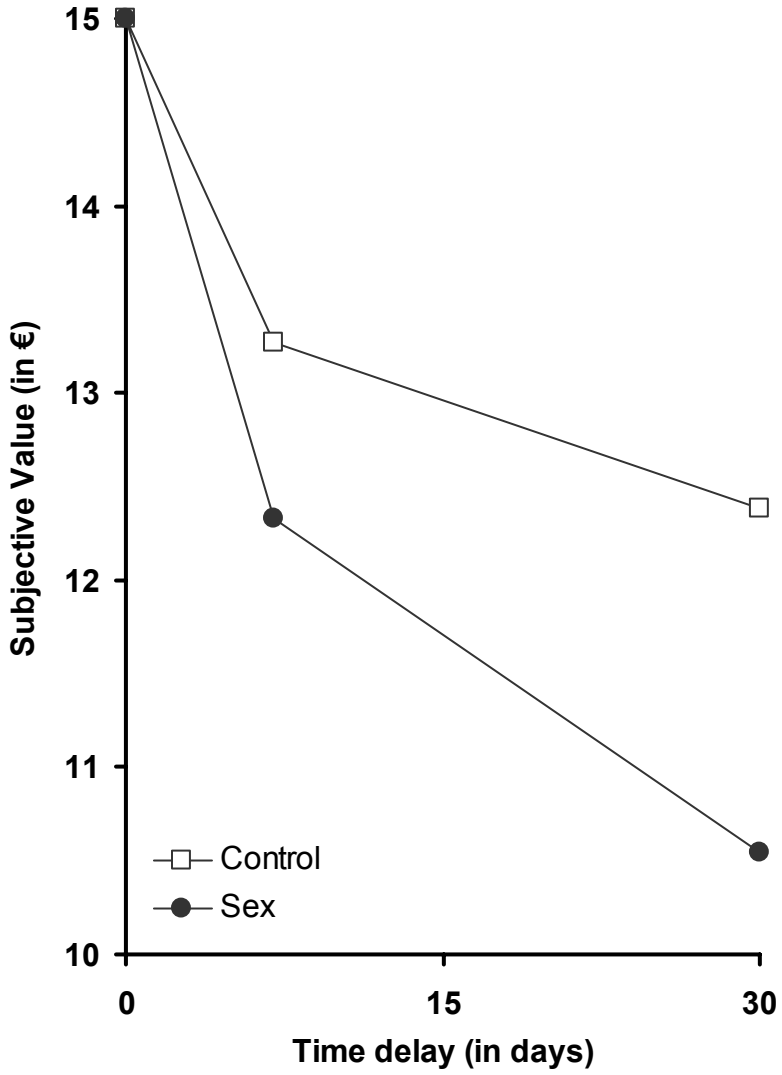

FIGURE 3

DELAY DISCOUNTING OF A MONETARY REWARD (EXPERIMENT 2)

Note.-Different superscripts indicate that the difference between means is significant ($p \leq .05$).

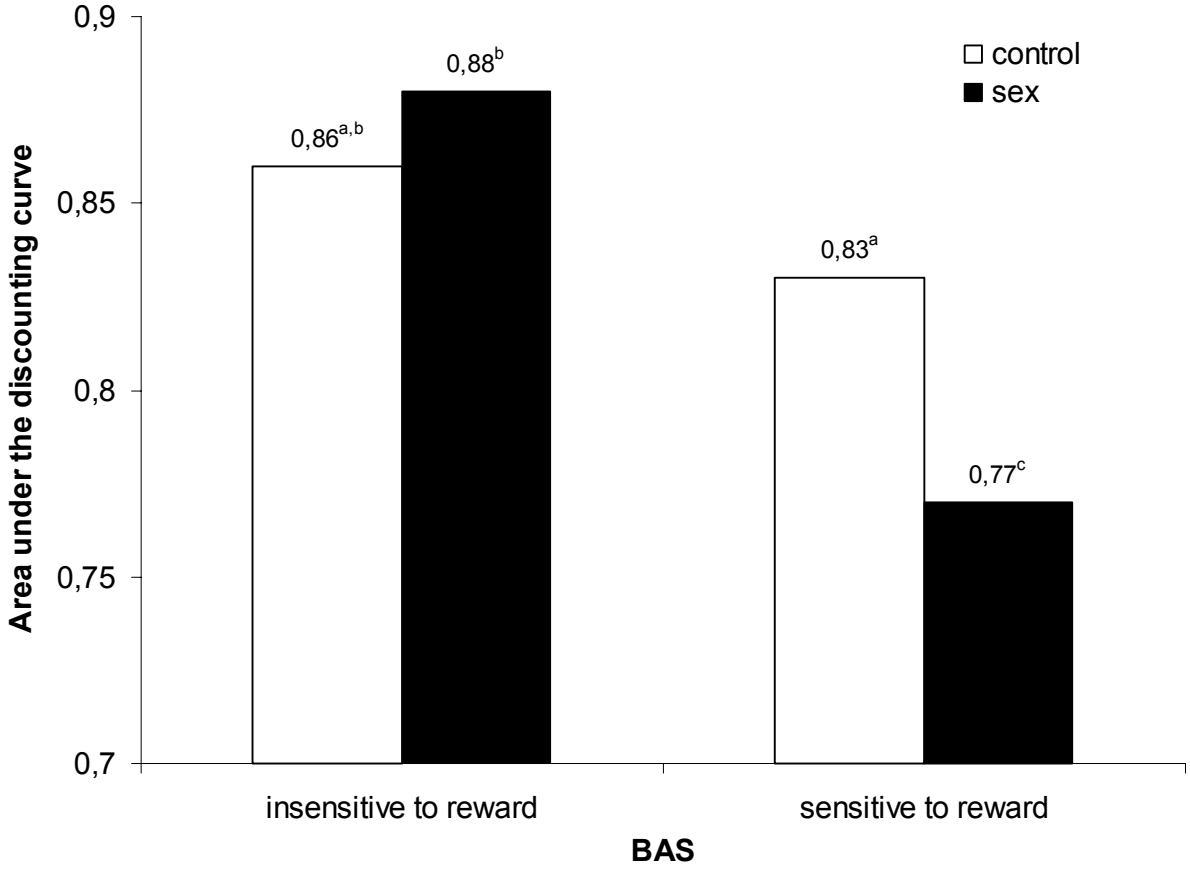

FIGURE 4

PERFORMANCE ON REMOTE ASSOCIATES TEST (EXPERIMENT 2)

Note.-Different superscripts indicate that the difference between means is significant ($p \leq .05$).

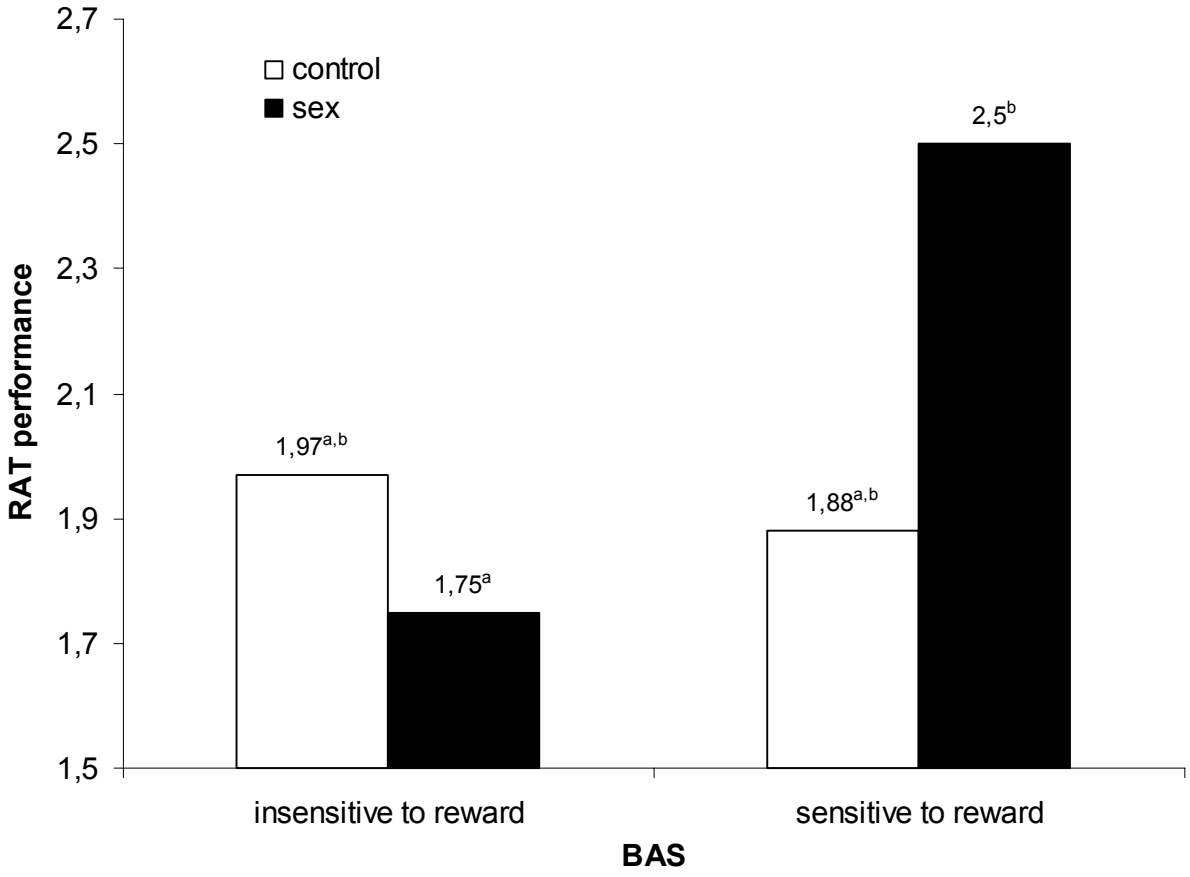

FIGURE 5

DELAY DISCOUNTING OF REWARDS (EXPERIMENT 3)

Note.-Different superscripts indicate that the difference between means is significant ($p \leq .05$).

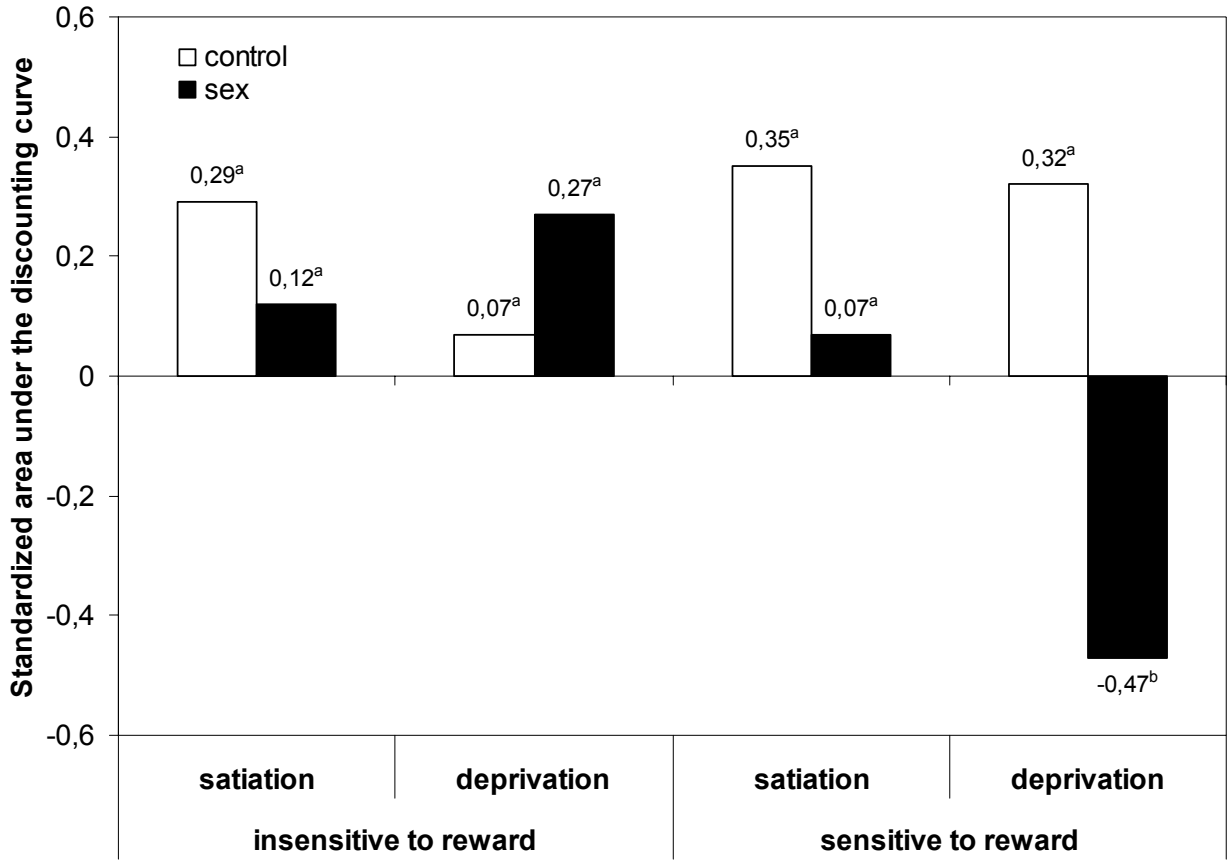

FIGURE 6

DELAY DISCOUNTING OF MONEY (EXPERIMENT 3)

Note.-Different superscripts indicate that the difference between means is significant ($p \leq .05$).

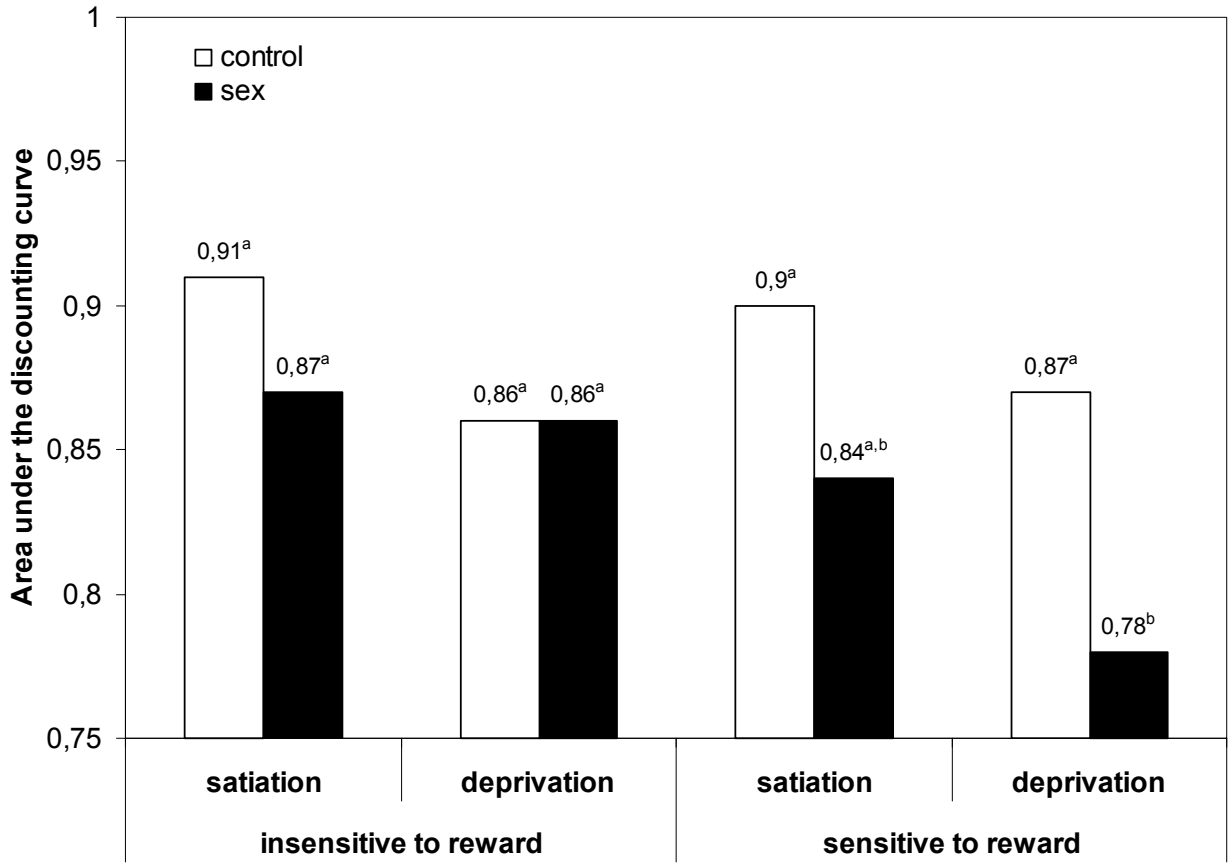

FIGURE 7

DELAY DISCOUNTING OF SODA POPS (EXPERIMENT 3)

Note.-Different superscripts indicate that the difference between means is significant ($p \leq .05$).

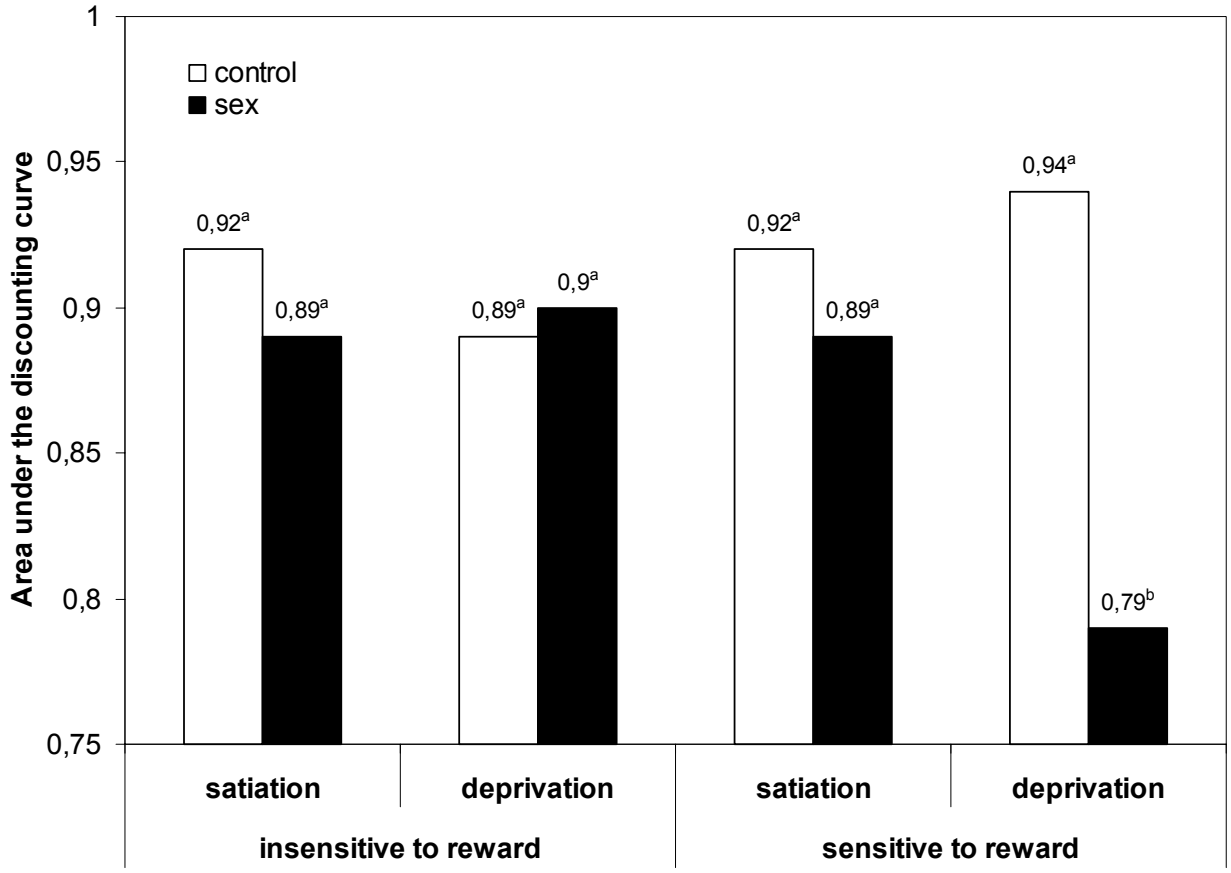

FIGURE 8

DELAY DISCOUNTING OF CANDY BARS (EXPERIMENT 3)

Note.-Different superscripts indicate that the difference between means is significant ($p \leq .05$).